**Objectives**

Upon completion of this activity, you will be able to:

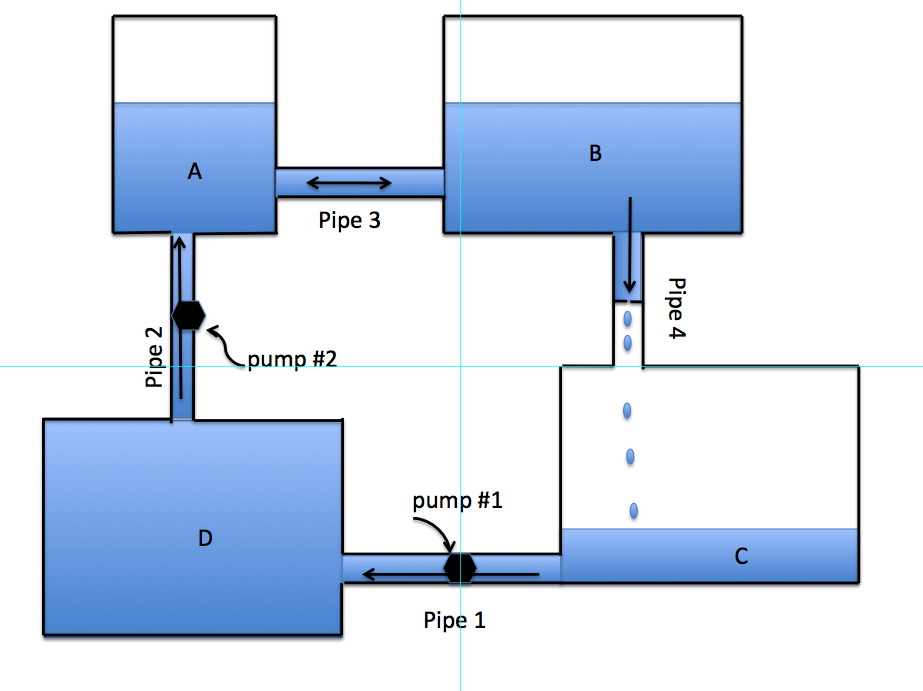
* Identify movement and/or change of matter as it moves through the water cycle.
* Define residence time and predict how a system is impacted by changes in residence time.

**Causal Principles**

1. Gravitational energy, thermal energy and/or chemical **energy** drive all movement and change of matter on Earth.
2. A system is in **equilibrium** when energy in the system is balanced.
3. Matter moves and changes to return a system to **equilibrium**.
4. **Energy** is needed to break bonds and is released when bonds form.
5. **Temperature** is a measure of the movement of molecules. Higher temperature means molecules are moving faster.

**PART 1: Class Notes**

**Part 1: Class Activity – Analogy between Simple System and Water Cycle**



|  |  |  |
| --- | --- | --- |
| **Simple system** | **Water cycle** | **Phase\*** |
| Container A | *Water vapor in atmosphere* | *Gas* |
| Container B |  |  |
| Container C |  |  |
| Container D |  |  |
| Pipe 1 | *Surface runoff* | *Liquid* |
| Pipe 2 |  |  |
| Pipe 3 |  |  |
| Pipe 4 |  |  |

Table A. Aligning the system to the water cycle.

\*If there is a phase change represented by an object, write both in the Phase column.

**Part 2: Group Work**

Fill in Table B as in the same way we filled in Table A together, but with container A now analogous to groundwater. The terms that you will use include: stream, atmosphere, condensation, surface water, discharge, evaporation, lake, cloud, precipitation.

|  |  |  |
| --- | --- | --- |
| **Simple system** | **Water cycle** | **Phase** |
| Container A |  |  |
| Container B |  |  |
| Container C |  |  |
| Container D | *Groundwater* |  |
| Container E |  |  |
| Container F |  |  |
| Pipe 1 |  |  |
| Pipe 2 |  |  |
| Pipe 3 |  |  |
| Pipe 4 |  |  |
| Pipe 5 | *Infiltration* |  |
| Pipe 6 | *discharge* |  |



Table B. Aligning the system to the water cycle including groundwater.

**Causal Principles**

When components of two domains are analogous, a common principle can be used to describe both. For every corresponding pair of components in Table C, identify the causal principle the two processes have in common.

Table C. Causal principles related to the water cycle

|  |  |  |
| --- | --- | --- |
| **Simple system** | **Water cycle** | **Causal Principle** |
| Water moves between containers | Water moves between reservoirs |  |
| Water is pumped in Pipe 2 | Energy is used for evaporation |  |
| Water drips in Pipe 4 | Precipitation |  |
| Water flows in one or two directions between containers. | Water my flow in one or two directions between reservoirs. |  |

**Part 3: Homework – Residence Time**

Residence time is the average amount of time that a material remains in a reservoir. Residence time is calculated by the following equation:

R.T. = amount in a reservoir ÷ flow in (or out) of the reservoir.

Complete Table D by listing changes in the water cycle that are similar to changes in the simple system. In the right-hand column, write increase, decrease or no change in the residence time based on you wrote in the middle column.

Table D

|  |  |  |
| --- | --- | --- |
| **Simple system** | **Water cycle** | **Effect on residence time** |
| Remove some of the water in container A from the whole system. | *Remove some water from groundwater* | *Decrease residence time of groundwater* |
| Decrease the rate of pumping (Pump #1). |  |  |
| Increase the hole size in Pipe #4 |  |  |
| Increase the amount of water in Reservoir C |  |  |